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Two Species of *Bryoria* (Lichenized Ascomycota, Parmeliaceae) from the Sino-Himalayas

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We performed a taxonomic study on two species of the genus *Bryoria* from the Sino-Himalayas, SW-China. *B. nadvornikiana* is new to China and *B. furcellata* is new to Yunnan and Sichuan provinces in the Sino-Himalayas. Morphology, habitat, distributions and chemistry of the two species are discussed.

KEYWORDS: ***Bryoria*, China, Distribution, Lichen, Morphology, Yunnan**

The northwestern part of Yunnan and western part of Sichuan provinces belongs to the Chinese Hengduanshan Mountains, which is part of the east of the great Himalayas and often eulogized as the third polar of the world (Wang, 1993). Average elevation is over 3,800 m in the area. This area is well known for its rich flora of lichen species in the world. Recently some interesting lichen species have been found from this area (Jorgensen, 1972; McCune *et al.*, 2003; Wang and Chen, 1994; Wang and Harada, 2001, 2003).

The genus of *Bryoria* Brodo & Hawksw belongs to order Lecanorales, suborder Lecanorineae, and family Parmeliaceae (Brodo and Hawksworth, 1977; Nash, 1996). It has the fruticose thalllus composed of a prominent cortex and medulla of arachnoid hyphae with Trebouxioid phycobionts, lateral apothecia, and colorless simple ascospores. Forty six species were accepted in the world (Brodo and Hawksworth, 1977). Among them, 14 species were known in India and Nepal of the South Himalayas (Awasthi and Awasthi, 1985), and 14 species were recorded in the Sino-Himalayas (Jorgensen, 1972; Wei, 1991; Wang and Chen, 1994; Wang and Harada, 2001; Wu and Wang, 1992). *Bryoria navornikiana* and *B. furcellata* were newly identified during the extensive herbarium study of the specimens. Morphology, habitat, chemistry and distribution of the two species were described in this paper.

Materials and Methods

One thousand two hundred specimens of *Bryoria* lichens were collected from the Sino-Himalayas since 1980. Descriptions of external morphology are based on air-dried materials and observed under a disseting stereomicroscope. Sections were made with a razor blade under the stereomicroscope and mounted in GAW (glycerol : ethanol : water = 1 : 1 : 1) for anatomical study. Chemical analyses were made by the color test and thin-layer chromatography (TLC) methods as described by Culberson (1972) with use of the solvent A (toluene : dioxane : acetic acid = 180 : 45 : 5). The specimens cited in this study are deposited in the Herbarium of Cryptogams, Kunming Institute of Botany, Academia Sinica (KUN-L).

Description

1. *Bryoria nadvornikiana* (Gyeln.) Brodo & Hawksw., Opera Bot. 42 (1977). = *Alectoria nadvornikiana* Gyeln., Acta Fauna Fl. Univ., ser. 2, 1: 6 (1932). (Fig. 1 A and B)

External Morphology: Thallus subpendent to pendent, 5~8 cm (~15 cm) long, main branches ca. 0.2~0.3 mm diameter, black only in basal parts, white to grayish brown towards apices, soft, shiny; isotomic-dichotomously branched, becoming to anisotomic-dichotomously branched towards the apices, with angles between the dichotomies rounded towards the base (70°~80°), and acute towards the apical part (ca. 30°~50°); branches cylindrical, even in diameter, tapering; lateral spinulose branches common, usually up to 1~5 mm long, not constricted at base, concolorous with the main branches, sometimes becoming brown at the apices; true lateral spinules lacking; pseudocyphellae sparse, slightly, plane to concave, fissured, concolorous with the thallus or dark brown, 0.2~0.5 mm long; soralia abundant to sparse or absent, broader than the branch, ellipsoid to more or less rounded, white, usually 0.5~1.5 mm diameter. Apothecia are rare, lateral, immersed when young, slightly geniculate when mature, thalline margin thin, ca. 0.1 mm think, entire, con-

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colorous with branch, disc 1.5 mm diameter, slightly concave when young, becoming convex, epruinose, brown. Pycnidia were not seen.

Anatomy: Middle parts of main branches in cross-section entirely circular, 175~220 μm diameter; cortex 35~40 μm thick, one-layered, smooth on surface, brownish in outermost, colorless in remainder; medullary hyphae not ornamented, 3~4 μm diameter; ascospores 8 per ascus, sub- globose to ellipsoidal, 5 × 6 μm, hyaline, simple, colorless, with 0.5 μm thick wall.

Chemistry: Medulla P-, K+ yellow, C-, KC-, CK-; Soredia P+ orange. TLC: alectorialic acid, barbatolic acid, atranorin, protocetraric acid, ± fumarprotocetraric acid, ± lecanoric acid.

Habitat and ecology: Very common on bark of *Pinus yunnanensis*, *P. densata*, *Rhododendron* spp., *Abies georgei*, *Larix* sp., *Juniperus* sp., sometimes on branches of *Quercus* spp., *Picea* spp.; 2100~4500 m elevation.

Distribution: Europe, North America, East African (Hawksworth, 1972; Borod and Hawksworth, 1977; Holien, 1989; Jorgensen and Galloway, 1983), Japan (Harada *et al*., 2004). New to China (Fig. 2).

Remarks: Thallus pendent, 3~5 cm (~10 cm) long, main branches 0.2~0.3 mm diameter, white to grayish brown, soft, shiny, lateral spinules branches common; pseudocyphellae sparse; soralia abundant to sparse or absent, broader than the branch, ellipsoid to rounded, white; medulla K+ yellow; the presence of barbatolic and alectorialic acids.

The taxon is close to *B. hengduanensis* in having thallus pendent, white to grayish brown, shiny, and true lateral spinules lacking. However, the latter has pseudocyphellae spiraling around the branches, and the presence of usnic acid. It is similar to *B. poeltii* by having soralia broader than the branch; but the latter has the thallus brown to dark brown and the absence of barbatolic and alectorialic acids.

Specimens examined: **YUNNAN** Prov. **Deqin** Co., Meilixueshan Mt., 28° 24'N, 98° 45'E, 2800~3500 m elevation, on *Picea* sp., Wang Lisong *94-15059**,** *94-15057, 94-15185, 94-15056, 94-15025, 94-15026a, 94-15028, 94-21039, 94-15027, 94-15430; Baimaxueshan Mt., 28° 22'N, 98° 59'E, 3750 m elevation, on *Abies* sp., Wang Lisong 81-2149b; Yongzhi to Tongda villege, 28° 05'N, 98° 41'E, 3700 m elevation, on *Picea* sp., Wang Lisong 99-18682; **Zhongdian** Co. Xiaozhongdian village, Jisha, 3500 m elevation, Wang Lisong 81-34a, 159a; Napahai lake, 3250 m elevation, on *Rhododendron* sp., Wang Lisong 98-18160b; Tianchi lake, 27° 37'N, 99° 38'E, 3700~3900 m elevation, on *Rhododendron* spp., *Picea* sp. and *Abies* sp., Wang Lisong *01-20931, 01-20928, *93-13662, 93-13659a, *93-13665, 93-23180, 94-14922, 04-23186; Bitahai lake, 3400 m elevation, on *Quercus* sp., Wang Lisong *94-14956a, *94-14957a; Dabaosi, 27° 46'N, 99° 46'E, 3200~3300 m elevation, on *Pinus densata*, *Picea* sp., *Abies* sp., *Larix* sp. & *Rhododendron* sp., Wang Lisong 93-13408a, *93-13397, 93-13398, *93-13396, 93-13424, 04-23220, 04-23228, 04-23219; Wufenshan Mt. 3300 m elevation, Lin Z-w 4412b, *4412d; Xiaoxueshan Mt. 28° 19'N, 99° 45'E, 3750~3900 m elevation, on *Abies* sp. & *Picea* sp., Wang Lisong *01-20857, 01-20879, 01-21017; Geza village, 28° 30'N, 99° 49'E, 3400 m elevation, on *Pinus yunnanensis*, Wang Lisong *00-20070b, 00-20070; Daxueshan Mt. 28° 34'N, 99° 49'E, 4100 m elevation, on *Quercus* sp., *Picea* sp., & *Abies* sp., Wang Lisong 00-19998, 01-20995, 01-20980, 01-23405, *01-20819, 04-23300, 04-23243; Habaxueshan Mt., 27° 20'N, 100° 04'E, on *Picea* sp., Wang Lisong *02-21820, *02-22034; **Lijiang** Co., Yulongxueshan Mt., Ganhaizi, 3100 m, on bark, Wang Lisong 04-23515, 04-23497; Heibashuei, 2750 m elevation, on *Pinus densata*, 94-14660; Laojuenshan Mt. 26° 39'N, 99° 46'E, 3500~3900 m elevation, on *Larix* sp. & *Abies* sp., 00-20205, 00-20284; **Gongshan** Co., Binzhongluo village to Tongda, 28° 05'N, 98° 41'E, 2500 m elevation, on *Pinus yunnanensis*, Wang Lisong 99-18667, on *Picea* sp., Wang Lisong *99-18662, 99-18662c. **SICHUAN** Prov., **Daocheng** Co., Yading, 28° 26'N, 100° 20'E, 4510 m elevation, on *Quercus* sp. and *Larix* sp., Wang Lisong 02-21584, 02-22238, 02-23409; **Xiangcheng** Co., Daxueshan Mt. 28° 34'N, 99° 49'E, 4300 m elevation, on *Rhododendron* sp. Wang Lisong 02-21407; **Wolong** Co., Balangshan Mt. 30° 54'N, 102° 53'E, 3200 m elevation, on *Quercus* sp., Wang Lisong 01-20641a; **Xiaojin** Co., Rilong village, 31° 02'N, 102° 52'E, 3200~3600 m elevation, on *Juniperus* sp. & *Larix* sp., Wang Lisong 96-16056, 96-17759, *01-20581, 01-20566, on bark of *Picea* sp., Wang Lisong 02-21065; **Yanyuan** Co., Dalin village, 3750 m elevation, on *Abies* sp., Wang Lisong *83-1154; **Jiulong** Co., Tanggu village, 3000 m elevation, on stump, *Larix* sp.,Wang Lisong 96-17445, 96-17440, 96-16573a, 96-16583a; **Miyi** Co., Malong village, Beipuoshan Mt., 2800~3000 m elevation, Wang Lisong 83-976, 83-881; **Muli** Co., Yala village, 3850 m elevation, on *Larix* sp., and *Picea* sp., Wang Lisong 83-1802, 83-2369. (* Specimens containing lecanoric acid).

2. *Bryoria furcellata* (Fr.) Brodo & D. Hawksw., Opera Bot. 42: 103(1977). = *Cetraria fucellata* Fr., Syst. Orb. Veget. 1: 283(1825). (Fig. 1 C and D)

External Morphology: Thallus caespitose, subpendent, main branch 5~7 cm long, 0.3~0.5 mm diameter, sometimes pale brown at the base, becoming pale brown to brown towards apices, rigid, dull; isotomic-dichotomously branched, with angles between dichotomies usually obtuse towards the base (usually 80°~90°), but becoming acute towards the apices (30°~45°); branches cylindrical to slightly compressed towards the base, lateral spinules rare or absent, usually 0.2~0.4 mm long, concolourous with the branches, dull; soralia abundant, fissural, narrower than

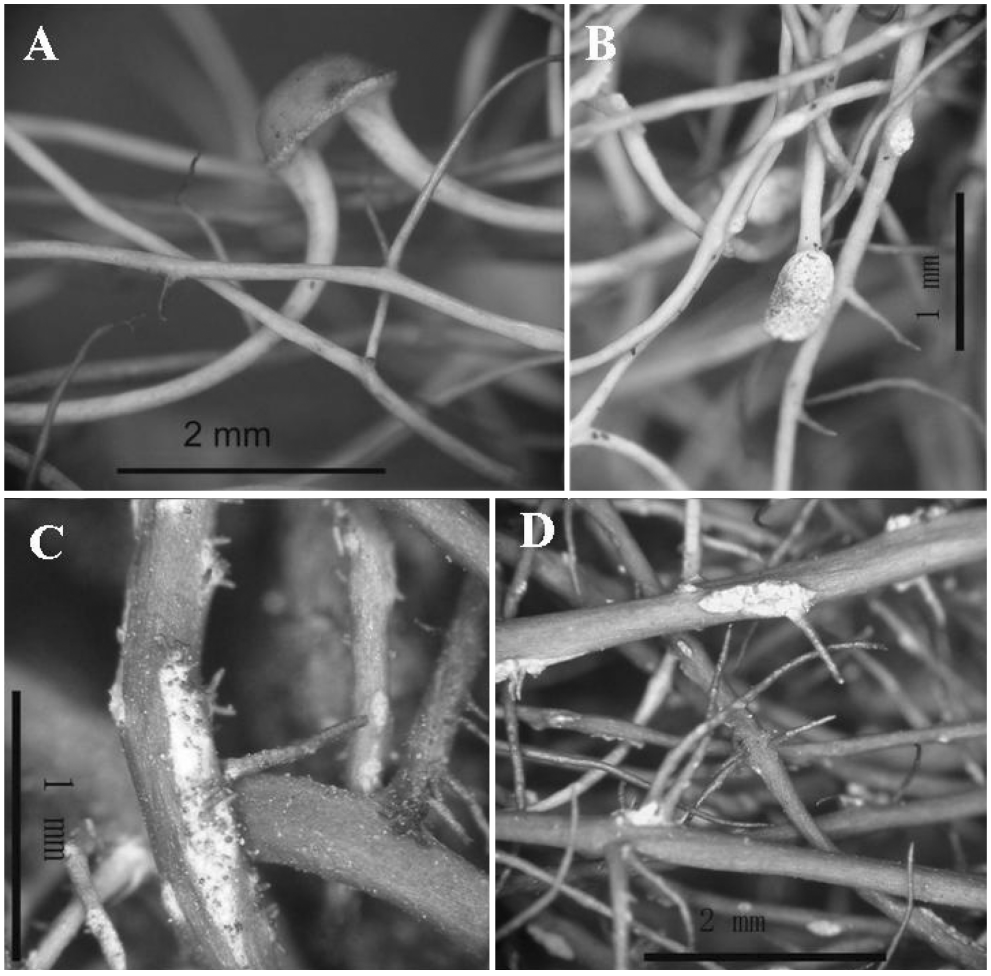

Fig. 1. A & B: Habit of *B. nadvonikiana* (Gyeln.) Brodo & Hawksw.; C & D: Habit of *B. furcellata* (Fr.) Brodo & Hawksw. A: branches with apothecia, Wang Lisong 94-14956a, B: branches with soralia and lateral spinules, Wang Lisong 00-20070, C: Soralia with isidiiform spinules, Wang Lisong 92-13155, D: soralia with spinecent branches, Wang Lisong 01-20707.

the branches, slightly raised, white to pale brown, 0.2~1.2 mm long, with tufts of isidiiform spinules, abundant, usually 1~1.5 mm long, but sometimes the isidiiform spinules becoming to spinules branches, up to 2 mm long; pseudocyphellae lacking. Apothecia and pycinicia were not seen.

Anatomy: Middle parts of main branches in cross-section entirely circular, 550~600 μm diameter; cortex 100~110 μm thick, one-layered, smooth on surface, brownish in outermost, colorless in remainder; medullary hyphae not ornamented, 5~9 μm diameter.

Chemistry: Medulla and soralia P+ orange-red, K± yellow, C-, KC± yellow, CK-; the presence of fumarprotocetraric acid, lobaric acid by TLC.

Habitat and ecology: Usually on bark of *Abies, Picea* and *Pinus* in the coniferous forest, sometimes also in broad-leaved forests, such as *Rhododendron* and *Quercus* in the alpine to the subalpine zone between 2450 and 4500 m elevation.

Distribution: Europe and America (Brodo and Hawksworth, 1977), Nepal (Awasthii and Awasthii, 1985), Japan (Harada *et al*., 2004), North east China (Wei, 1991). New to Yunnan and Sichuan (Fig. 2).

Remarks: *Bryoria furcellata* is characterized by the thallus isotomic-dichotomously branched, soralia narrower than the branches, with tufts of isidiiform spinules (sometimes up to 1~1.5 mm long) and the presence of fumarprotocetraric acid and lobaric acid (some of our specimens contain this acid).

This species is similar to *B. variabilis* (Bystrek, 1969) and *B. smithii* (Du Rietz, 1926) in both having fissural soralia and tufts of isidioid spinules. However, the latters have anisotomic-dichotomously branched thallus and lack lichen product. It is also close to *B. perspinosa* (Bystrek, 1969). However, the latter has thallus anisotomic-dichotomously branched with lateral spinules sparse to numerous in the middle and the basal parts of thallus.

Specimens examined: **YUNNAN** Prov., **Luquan** Co., Jiaozixueshan Mt., 26° 5'N, 102° 8'E, 3000~3900 m elevation, on stump, *Rhododendron* sp. & *Abies* sp., Wang

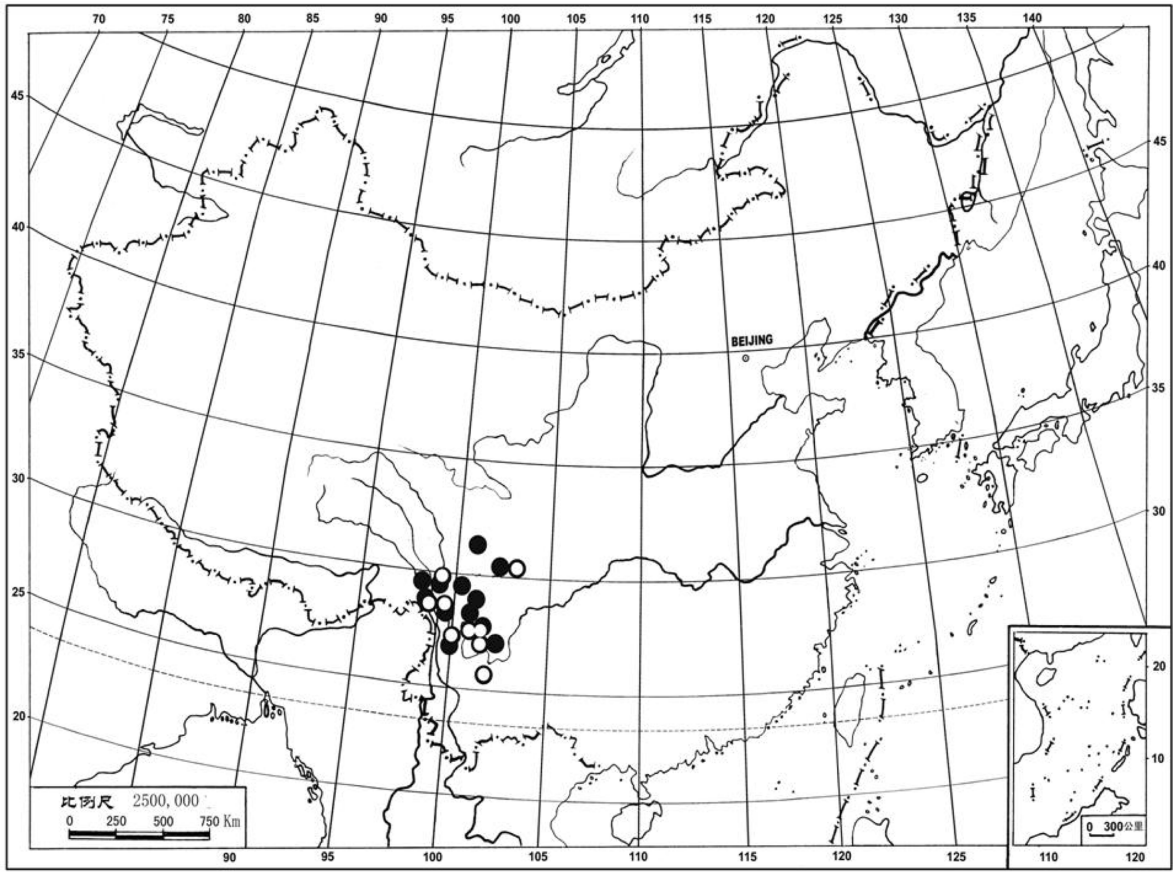

Fig. 2. Distribution of *Bryoria nadvonikana* (●) and *B. furcellata* (○) in the Sino-Himalayas.

Lisong 92-13155, 93-13308, 00-20379, 00-20380, 00-20382, 00-20381; **Zhongdian** Co., Bitahai lake, 27° 44'N, 99° 58'E, 3400 m elevation, on *Sorbus* sp., Wang Lisong 01-20707; Wenshuei village, Daxueshan Mt., 28° 34°N, 99° 49'E, 4100~4500 m elevation on *Quercus* sp. & *Rhododendoron* sp., Wang Lisong 00-20445, 01-20715, 01-20997, 01-23399; **Lijiang** Co., Yulongxueshan Mt. Ganhaizi, 3100 m, on branches of *Quercus* sp., Wang Lisong 04-23519; **Gongshan** Co., Binzhongluo village, 28° 05'N, 98° 41'E, 2500~3500 m elevation, on *Pinus yunnanensis*, and *Picea* sp., Wang Lisong 99-18666, 99-18662a; Binzhongluo to Tongda village, 28° 05'N, 98° 41'E, 3800 m elevation, on *Picea* sp., Wang Lisong 99-18531; **Deqin** Co., Meilixueshan Mt. Xiaonong village, 2800 m elevation, on *Pinus* sp., Wang Lisong 94-1536; Baimaxueshan Mt., 4200 m elevation, on *Larix* sp., Wang Lisong 93-13325. **SICHUAN** Prov., **Yanyuan** Co., Lianhe village, Huolushan Mt. 3450 m elevation, on *Rhododendron* sp., Wang Lisong 83-1344; **Luding** Co., Gonggaxueshan Mt., 29° 20'N, 101° 30'E, 2450 m elevation, on *Picea* sp., Wang Lisong 96-17339a; **Miyi** Co., Malong village, 3000~3200 m elevation, Wang Lisong 83-763, 83-884b; **Hueili** Co., Longzhoushan Mt., 3000~3500 m elevation, on *Rhododendron* sp., Wang Lisong 97-17909, 96-18070, 96-18018, 96-17967a.

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